

REMARKS

Response to the §112 Rejection

In the September 15, 2006 Office Action, the Examiner rejected claims 1-18 under 35 U.S.C. §112, second paragraph as allegedly indefinite for reciting the term “retention-effective amount of a transglutaminase” and suggested Applicants to replace this term with the quantitative range of transglutaminase described on page 3, first paragraph of the instant specification.

In response, Applicants have hereby amended claims 1 and 10, from which claims 2-9 and 11-18 depend, to positively recite a composition “containing a transglutaminase in an amount of from about 0.004% to about 0.025% by weight of the composition.” Further, claims 6-7 and 15-16 have been amended to recite transglutaminase in the amounts of “from about 0.006% to about 0.017% by weight” and “from about 0.0086% to about 0.0135% by weight,” respectively. Support for such claim amendments can be found in the instant specification on page 3, lines 5-8.

Such claim amendments are consistent with the Examiner’s suggestion in the September 15, 2006 Office Action, and the amended claims 1-18 therefore overcome the §112 rejection.

Response to the §102 Rejections

In the September 15, 2006 Office Action, the Examiner rejected claims 1-3, 6-12 and 15-18 under 35 U.S.C. §102(b) as allegedly anticipated by Japanese Patent Application Publication Number 02-204407 filed by Kanebo Ltd (hereinafter “Kanebo”) as evidenced by Japanese Patent Application Publication Number 03-213574 filed by Ajinomoto KK (hereinafter “Ajinomoto”).

In response, Applicants have hereby amended claim 1, from which claims 2-3 and 6-9 depend, to positively recite a method of “retaining curl in a curled human keratinous material which comprises applying to the curled human keratinous material a composition containing a transglutaminase...” Applicants have also amended claim 10, from which claims 11-12 and 15-18 depend, to positively recite a method of “enhancing curl in a curled human keratinous material which comprises applying to the curled human keratinous material a composition containing a transglutaminase...” Further, claims 3 and 12 have been amended to further specify that the curled human keratinous material is “human hair that is curled naturally, chemically or mechanically.” Support for such claim amendments can be found in the instant specification on page 2, lines 20-22, page 3, lines 12-13, page 4, lines 15-26, and page 8, line 24.

It is important to note that the amended claims 1-3, 6-12 and 15-18 of the present application are not directed to a transglutaminase-containing composition; instead, such claims are directed to new methods of using a transglutaminase-containing composition for retaining or enhancing curl in a curled human keratinous material. Specifically, such new methods comprise the step of “applying [the composition] to the curled human keratinous material”, as positively recited by the amended claims 1-3, 6-12 and 15-18.

In order to establish anticipation under 35 U.S.C. §102, a prior art reference must disclose every limitation of the claimed invention, either *explicitly* or *inherently*. In re Schreiber, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997). However, nothing in the Kanebo reference discloses, either explicitly or inherently, the application of a transglutaminase-containing composition to a curled human keratinous material, as positively recited by the amended claims 1-3, 6-12 and 15-18 of the present application.

Kanebo only discloses application of a hair cosmetic composition containing protein-modified transglutaminase and water-soluble polyalcohols to damaged hair that is caused by frequent drying, repeated hair treatments such as cold perms, and over-washing (see the English translation of Kanebo, page 2, lines 2-6 and 27-28). Kanebo indicates that the transglutaminase catalyzes the reaction between the glutamine residue and the lysine residue of the outermost layer of hair and cross-linking via ϵ -(γ -glutamyl)lysine bonding, which in turn results in refinement of the epidermal structure, improvement of damaged hair, increase in the moisture retention power, and improved integrity of hair (see the English translation of Kanebo, page 3, lines 11-15). More specifically, Kanebo discloses that the damaged hair is imparted with gloss, shine, softness, springiness, elasticity and flexibility (see the English Abstract and the English Translation of Kanebo on page 2, lines 32-33 and page 3, line 15).

It is self-evident that damaged hair is different from curled hair: on one hand, damaged hair can be caused by various reasons, such as frequent drying, repeated hair treatments, and over-washing (as described in the English translation of Kanebo, page 2, lines 2-6 and 27-28); on the other hand, curled hair may or may not be damaged, and typically, naturally curled hair that has not been chemically treated may not show any damage at all. Therefore, the mere disclosure by Kanebo about applying transglutaminase to improve damaged hair does not constitute an explicit or inherent disclosure of applying transglutaminase to curled hair.

In the September 15, 2006 Office Action, the Examiner attempted to stretch and extend the limited disclosure of Kanebo on treating damaged hair to cover curled hair, by equating the words “springiness,” “flexibility,” and “elasticity,” which are used by Kanebo to describe the improvements achieved on damaged hair, with the concept of curled hair.

However, springiness, flexibility, and elasticity are characteristics common to all human hair, whether curled or not, and mere disclosure of such characteristics cannot be extrapolated or extended to equate with a disclosure of curled hair. A single strand of human hair is formed of millions of α -keratin fibers. At the micro level, two α -keratin helices twist around each other to form a coiled coil structure having a dimension of approximately 450 \AA or 0.045 micron, as shown by Figure 6-15(a) on page 139 of FUNDAMENTALS OF BIOCHEMISTRY: LIFE AT THE MOLECULAR LEVEL by Donald Voet, Judith G. Voet, and Charlotte W. Pratt, 2nd Edition (hereinafter “VOET & VOET”). Multiple coiled coils are then assembled into more complex structures (such as the microfibril and protofibrils as shown in Figure 6-15(c) on page 139 of VOET & VOET and the microfibril as described on page 139, first full paragraph of VOET & VOET) that eventually form a single strand of human hair at the macro level (i.e., observable by the human eye). Specifically, VOET & VOET indicates that the springiness of human hair is a consequence of the coiled coil's tendency to recover its original conformation after being untwisted by stretching (see page 139, first sentence of the second full paragraph in VOET & VOET). Since all human hair is formed of the coiled coil structures at the micro level (i.e., about 0.045 micron), all human hair has a springy quality with inherent elasticity and flexibility. Therefore, the general disclosure by Kanebo about enhanced springiness, elasticity, and flexibility in hair does not constitute a specific disclosure of curled hair.

The Examiner asserted in the September 15, 2006 Office Action that:

“When curls are made springier or more elastic, they are enhanced, because their appearance and texture are softer. They are also retained better (and enhanced because they are retained better) than if they were not elastic, because if they were not elastic, a force causing them to straighten without the ability to bounce back would leave the hair straight.” (See Office Action, page 3, lines 17-21.)

Unfortunately, the Examiner's assertion bears little, if any, relevance to the anticipation question of this case. Kanebo fails to disclose application of transglutaminase to curled hair, while such disclosure is necessary for establishing anticipation of the claimed invention of the present application. The Examiner's assertion that curled hair, if made springier or more elastic, can be enhanced and retained better does not remedy the above-mentioned deficiency of Kanebo, nor does it bridge the gap between the Kanebo reference and the claimed invention of the present application.

The Examiner further asserted in the September 15, 2006 Office Action that the Kanebo reference discloses Applicants' composition and the claimed one-step method of applying this composition to hair, and that "*Kanebo's method and Applicants' method are the same*" (see Office Action, page 4, lines 8-9). However, Applicants respectfully traverse this assertion. Kanebo's method involves application of transglutaminase to damaged hair, while the claimed methods of the present application, as positively recited by the amended claims 1-3, 6-12 and 15-18, involve application of transglutaminase to a curled human keratinous material, e.g., hair or eyelashes that are curled either naturally or artificially by mechanical or chemical means. As discussed above, damaged hair is not the same as curled hair. Further, nothing in Kanebo specifically discloses application of transglutaminase to curled hair. Therefore, it is clear that Kanebo's method and the claimed methods of the present application are not the same, despite the Examiner's assertion.

The Examiner in the September 15, 2006 Office Action also rejected the claimed invention of the present application on the ground that the Kanebo reference *inherently* discloses the claimed methods of the present application. Specifically, the Examiner asserted that Kanebo's method "*inherently has the same effect*" as Applicants' method and that Kanebo uses

transglutaminase in the same way that Applicants do and thus achieves the same result as Applicants do (see Office Action, page 4, lines 10-12).

However, it is improper for the Examiner to establish inherent anticipation upon mere speculation of potential effect of Kanebo's method on curled hair, when Kanebo is completely deficient in disclosing the application of its method to curled hair. Since there is no specific disclosure of applying transglutaminase to curled hair by the Kanebo reference, and since there is no evidence that such an application was even contemplated by Kanebo, there can be no inherency based on the Kanebo reference.

In Perricone v. Medicis Pharmaceutical Corp., 77 USPQ2d 1321 (Fed. Cir. 2005), the Court of Appeals for the Federal Circuit (hereinafter "the Court") held that claim 1 of US Patent No. 5,409,693, which recites a method for treating skin sunburn by topically "applying to the skin sunburn" a specific composition, is not anticipated by a prior art reference Pereira, which discloses a method of applying such a composition to skin in general. Specifically, the Court stated that when the claim specifically recites application of the composition to "skin sunburn," the issue is not whether the composition disclosed by Pereira, *if applied to skin sunburn*, would inherently treat that damage, but whether Pereira discloses the application of its composition to skin sunburn. The Court then held that the disclosed use of Pereira's composition, i.e., topical application, does not suggest application of such a composition to skin sunburn.

Correspondingly, the Court found that the use of the Pereira's composition for treating skin sunburn constitutes a new use of said composition that is patentable over Pereira. See Perricone, 77 USPQ2d at 1328.

Likewise in the present case, the disclosed application of transglutaminase by Kanebo to damaged hair in general is not anticipatory of the present invention of specifically applying

transglutaminase to curled hair. Similar to Perricone, the relevant question for determining inherency in this case is not whether the transglutaminase-containing composition disclosed by Kanebo, if applied to curled hair, would inherently retain or enhance curl therein, but whether Kanebo inherently discloses the application of the transglutaminase-containing composition to curled hair.

It has been well established that inherency may not be established by probabilities or possibilities, and the mere fact that a certain thing may result from a given set of circumstances is not sufficient. In re Oelrich, 212 USPQ 323, 326 (CCPA 1981). Inherent anticipation requires that the missing descriptive material is “*necessarily present*,” not merely probably or possibly present, in the prior art. Trintec Indus., Inc. v. Top-U.S.A. Corp., 63 USPQ2d 1597, 1599 (Fed. Cir. 2002).

The missing descriptive material in this case is the application of the transglutaminase-containing composition to a curled human keratinous material. Kanebo only discloses application of the transglutaminase-containing composition to damaged hair. As mentioned hereinabove, damaged hair and curled hair are fundamentally different concepts. Damaged hair is not necessarily curled hair. Even hair damaged by repeated cold perms is not necessarily curled hair. Because cold perm can be used both for making curly hair straight and for making straight hair curly, the repeatedly cold-permed hair can either be straight hair or curled hair. The mere probability or possibility that the damaged hair disclosed by Kanebo may be curled hair is therefore not sufficient for establishing inherency. Therefore, Kanebo’s disclosure about applying a transglutaminase-containing composition to damaged hair does not inherently anticipate application of the transglutaminase-containing composition to curled human

keratinous material, as positively recited by the amended claims 1-3, 6-12 and 15-18 of the present application.

In summary, Kanebo fails to disclose, either explicitly or inherently, application of a transglutaminase-containing composition to a curled human keratinous material, and therefore does not anticipate the amended claims 1-3, 6-12 and 15-18 of the present application.

In the September 15, 2006 Office Action, the Examiner cited Ajinomoto in support of the assertion that the method of Kanebo enhances and retains the curl in hair (see Office Action, page 4, lines 15-16).

However, as mentioned hereinabove, the relevant question in this case is not whether the disclosed prior art composition, *if applied to curled hair*, would inherently retain or enhance curl therein, but whether the prior art inherently discloses the application of said composition to curled hair. Applicants have already explained hereinabove the deficiency of Kanebo, i.e., it fails to disclose, either explicitly or inherently, the application of transglutaminase to curled hair. The Ajinomoto reference discloses application of transglutaminase to animal wool fiber for improving the shrinkage resistance, anti-pilling property, and hydrophobic property of the animal wool fiber (see the English translation of Ajinomoto, page 3, first and last paragraphs). However, Ajinomoto is completely deficient in disclosing application of transglutaminase to a human keratinous material. The disclosure by Ajinomoto about applying transglutaminase to animal wool fiber in general, which may or may not be curled, does not provide any derivative basis for applying transglutaminase to a curled human keratinous material. Therefore, Ajinomoto cannot remedy the deficiency of Kanebo.

Based on the foregoing, Applicants hereby request the Examiner to withdraw the §102 rejections of claims 1-3, 6-12 and 15-18.

Response to the §103 Rejections

In the September 15, 2006 Office Action, the Examiner rejected claims 1-4, 6-13 and 15-18 under 35 U.S.C. §103 as allegedly obvious over Kanebo in view of Ajinomoto further in view of Dane, Hair Chemistry 1, the Trichological Society, www.hairscientists.org/hair-chemistry.htm, ©2000, printed from the Internet on July 26, 2004 (hereinafter “Dane”) and BRENDA, http://www.brenda.uni-koeln.de/php/result_flat.php4?ecno=2.3.2.13, printed from the Internet on July 26, 2004 (hereinafter “Brenda”). Further, the Examiner rejected claims 5 and 14 under 35 U.S.C. §103 as allegedly obvious over Kanebo in view of Ajinomoto, Dane, Brenda and further in view of the product literature for eyelash perms from E-Z Permanent Makeup available at <http://www.eyelashperm.com> and <http://www.ezpermanentmakeup.com>, printed from the Internet on July 26, 2004 (hereinafter “E-Z Permanent Makeup”).

Claims 1 and 10, from which claims 2-9 and 11-18 depend, have been amended herein to positively recite a method of retaining or enhancing curl in a curled human keratinous material by “**applying to the curled human keratinous material a composition containing a transglutaminase...**”

As explained hereinabove, both Kanebo and Ajinomoto fail to disclose the application of a transglutaminase-containing composition to a curled human keratinous material.

The Dane reference only discloses use of conventional perm agents for disrupting existing disulfide bonds in the keratin fibers of hair and forming new disulfide bonds therein to

creating curls and waves in hair. Nothing in Dane teaches or suggests the use of transglutaminase, let alone the application of transglutaminase to curled hair.

In the September 15, 2006 Office Action, the Examiner asserted that one of ordinary skill in the art at the time that the invention was made “would have known that in designing a product to retain or enhance the curl of permed hair, it would have been necessary to have included an ingredient that can cross-link keratin to maintain the shape of the hair to which the product is applied” and that “one of ordinary skill in the art would have reasonably expected that when the cross-linking agent transglutaminase was applied to curly hair, . . . the cross-linking would have maintained the shape of the hair” (Office Action, page 5, lines 15-24).

The Examiner, by so asserting, seems to suggest that the prior art disclosure about using the disulfide-bond-forming cross-linking agents for curling hair renders it obvious to use any cross-linking agent for curling hair, regardless of what type of bonds are formed by such cross-linking agent. However, there are many different types of bonds in the keratin fibers that form human hair, including, but not limited to: the peptide bonds, the disulphide bonds, the salt bonds, and the hydrogen bonds (see Dane, page 2, lines 1-6), which have significantly different orientations, strength, and functions. In generally, conventional perming products rely on cross-linking agents for cross-linking cysteine residues in keratin to form disulfide bonds between the keratin strands, which result in the permanent curly shape of the hair. There is no teaching or suggestion in the cited prior art that cross-links between other types of amino acid residues and formation of other types of bonds can similarly lead to the permanent curly shape of the hair or retention/enhancement thereof. Therefore, the assertion by the Examiner that one of ordinary skill in the art would have reasonably expected that the cross-linking effectuated by application of transglutaminase, which forms ϵ -(γ -glutamyl)lysine bonds instead of disulfide bonds, would

have maintained the shape of the hair has no evidentiary basis in the cited prior art and cannot be used to support a *prima facie* case of obviousness.

In light of the complete absence of any teaching or suggestion by Dane about the use of transglutaminase or application thereof to curled hair, Applicants submit that Dane cannot remedy the deficiency of Kanebo and Ajinomoto.

The applied disclosure of the Brenda reference is limited to a human transglutaminase having a pH optimum of 6, but it does not teach or suggest any specific application of the human transglutaminase, much less the application of the human transglutaminase to curled human keratinous material. Therefore, Brenda does not remedy the above-described deficiency of Kanebo, Ajinomoto, and Dane.

The applied disclosure of E-Z Permanent Makeup is limited to conventional perming agents and the application thereof to eyelashes. Similar to Dane, nothing in E-Z Permanent Makeup teaches or suggests the use of transglutaminase, let alone the application of transglutaminase to curled eyelashes or hair. Therefore, E-Z Permanent Makeup cannot remedy the deficiency of Kanebo, Ajinomoto, Dane, and Brenda.

Correspondingly, Applicants request the Examiner to reconsider, and upon reconsideration to withdraw, the §103 rejections of claims 1-18.

In view of the foregoing amendments and remark, it is firmly believed that the present application is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,



Yongzhi Yang (Reg. No. 56,310)
Estée Lauder Companies
155 Pinelawn Road
Suite 345 South
Melville, NY 11747

Telephone No.: 631-414-6089
Facsimile No.: 631-531-1340

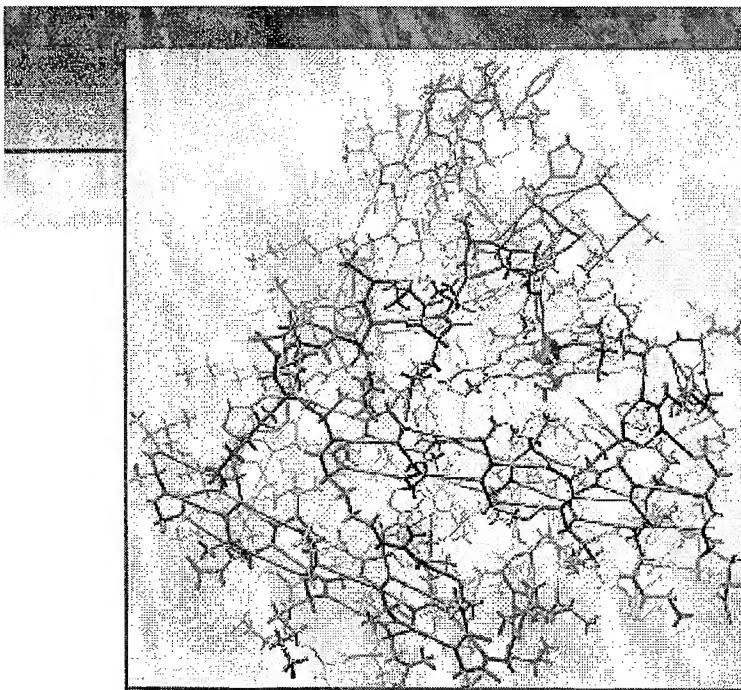
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THE EDITION

FUNDAMENTALS OF
BIOCHEMISTRY
LIFE AT THE MOLECULAR LEVEL

CHAPTER

6



The atomic structure of myoglobin, an oxygen binding protein, is drawn here as a stick model. The overall conformation of a protein such as myoglobin is a function of its amino acid sequence. How do noncovalent forces act on a polypeptide chain to stabilize its unique three-dimensional arrangement of atoms? [Illustrations, Irving Geis. Image from the Irving Geis Collection/Howard Hughes Medical Institute. Rights owned by HHMI. Reproduction by permission only.]

Proteins: Three-Dimensional Structure

1. Secondary Structure
 - A. The Peptide Group
 - B. Regular Secondary Structure: The α Helix and the β Sheet
 - C. Fibrous Proteins
 - D. Nonrepetitive Protein Structure
2. Tertiary Structure
 - A. Determining Protein Structures
 - B. Side Chain Location and Polarity
 - C. Supersecondary Structure and Domains
 - D. Protein Families
3. Quaternary Structure and Symmetry
4. Protein Stability
 - A. Forces That Stabilize Protein Structure
 - B. Protein Dynamics
 - C. Protein Denaturation and Renaturation
5. Protein Folding
 - A. Protein Folding Pathways
 - B. Protein Disulfide Isomerase
 - C. Molecular Chaperones
 - D. Diseases Caused by Protein Misfolding
6. Structural Bioinformatics

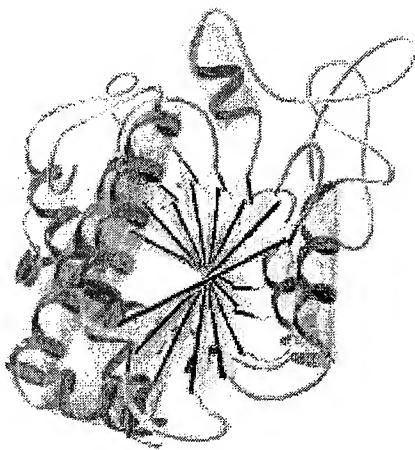


Figure 6-12 Diagram of a β sheet in bovine carboxypeptidase A. The polypeptide backbone is represented by a ribbon with α helices drawn as coils and strands of the β sheet drawn as purple arrows pointing toward the C-terminus. Side chains are not shown. The eight-stranded β sheet forms a saddle-shaped curved surface with a right-handed twist. [After a drawing by Jane Richardson, Duke University. Based on an X-ray structure by William Lipscomb, Harvard University. PDBid 3CPA (for the definition of "PDBid", see Section 6-6).]

Parallel β sheets containing fewer than five strands are rare. This observation suggests that parallel β sheets are less stable than antiparallel β sheets, possibly because the hydrogen bonds of parallel sheets are distorted compared to those of the antiparallel sheets (Fig. 6-9). β Sheets containing mixtures of parallel and antiparallel strands frequently occur.

β Sheets almost invariably exhibit a pronounced right-handed twist when viewed along their polypeptide strands (Fig. 6-12). Conformational energy calculations indicate that the twist is a consequence of interactions between chiral L-amino acid residues in the extended polypeptide chains. The twist distorts and weakens the β sheet's interchain hydrogen bonds. The geometry of a particular β sheet is thus a compromise between optimizing the conformational energies of its polypeptide chains and preserving its hydrogen bonding.

The **topology** (connectivity) of the polypeptide strands in a β sheet can be quite complex. The connection between two antiparallel strands may be just a small loop (Fig. 6-13a), but the link between tandem parallel strands must be a crossover connection that is out of the plane of the β sheet (Fig. 6-13b). The connecting link in either case can be extensive, often containing helices (e.g., Fig. 6-12).

C Fibrous Proteins

Proteins have historically been classified as either **fibrous** or **globular**, depending on their overall morphology. This dichotomy predates methods for determining protein structure on an atomic scale and does not do justice to proteins that contain both stiff, elongated, fibrous regions as well as more compact, highly folded, globular regions. Nevertheless, the division helps emphasize the properties of fibrous proteins, which often have a protective, connective, or supportive role in living organisms. The two well-characterized fibrous proteins we discuss here—keratin and collagen—are highly elongated molecules whose shapes are dominated by a single type of secondary structure. They are therefore useful examples of these structural elements.

α Keratin—A Coiled Coil. Keratin is a mechanically durable and chemically unreactive protein that occurs in all higher vertebrates. It is the principal component of their horny outer epidermal layer and its related appendages such as hair, horn, nails, and feathers. Keratins have been classified as either α keratins, which occur in mammals, or β keratins, which occur in birds and reptiles. Mammals each have over 30 keratin variants that are expressed in a tissue-specific manner.

The X-ray diffraction pattern of α keratin resembles that expected for an α helix (hence the name α keratin). However, α keratin exhibits a 5.1- \AA spacing rather than the 5.4- \AA distance corresponding to the pitch of the α helix. This discrepancy is the result of *two α keratin polypeptides, each of which forms an α helix, twisting around each other to form a left-handed coil*. The normal 5.4- \AA repeat distance of each α helix in the pair is thereby tilted relative to the axis of this assembly, yielding the observed 5.1- \AA spacing. The assembly is said to have a coiled coil structure because each α helix itself follows a helical path.

The conformation of α keratin's coiled coil is a consequence of its primary structure: The central \sim 310-residue segment of each polypeptide chain has a 7-residue pseudorepeat, *a-b-c-d-e-f-g*, with nonpolar residues predominating at positions *a* and *d*. Since an α helix has 3.6 residues per turn, α keratin's *a* and *d* residues line up along one side of each α helix (Fig. 6-14a). The hydrophobic strip along one helix associates with the hy-

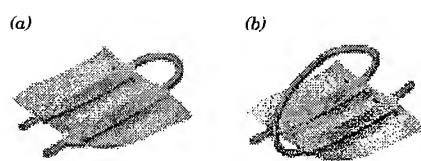


Figure 6-13 Connections between adjacent strands in β sheets. (a) Antiparallel strands may be connected by a small loop. (b) Parallel strands require a more extensive crossover connection. [After Richardson, J.S., *Adv. Protein Chem.* 34, 196 (1981).]

drophobic strip on another helix. Because the 3.5-residue repeat in α keratin is slightly smaller than the 3.6 residues per turn of a standard α helix, the two keratin helices are inclined about 18° relative to one another, resulting in the coiled coil arrangement. This conformation allows the contacting side chains of each helix to interdigitate (Fig. 6-14b). Coiled coils also occur in numerous, not necessarily fibrous, proteins.

The higher order structure of α keratin is not well understood. The N- and C-terminal domains of each polypeptide facilitate the assembly of coiled coils (dimers) into protofilaments, two of which constitute a protofibril (Fig. 6-15). Four protofibrils constitute a microfibril, which associates with other microfibrils to form a macrofibril. A single mammalian hair consists of layers of dead cells, each of which is packed with parallel macrofibrils.

α Keratin is rich in Cys residues, which form disulfide bonds that cross-link adjacent polypeptide chains. The α keratins are classified as "hard" or "soft" according to whether they have a high or low sulfur content. Hard keratins, such as those of hair, horn, and nail, are less pliable than soft keratins, such as those of skin and callus, because the disulfide bonds resist deformation. The disulfide bonds can be reductively cleaved by disulfide interchange with mercaptans (Section 5-3A). Hair so treated can be curled and set in a "permanent wave" by applying an oxidizing agent that reestablishes the disulfide bonds in the new "curled" conformation. Conversely, curly hair can be straightened by the same process.

The springiness of hair and wool fibers is a consequence of the coiled coil's tendency to recover its original conformation after being untwisted by stretching. If some of its disulfide bonds have been cleaved, however, an α keratin fiber can be stretched to over twice its original length. At this point, the polypeptide chains assume a β sheet conformation. β Keratin, such as that in feathers, exhibits a β -like pattern in its native state.

Collagen—A Triple Helix. Collagen, which occurs in all multicellular animals, is the most abundant vertebrate protein. Its strong, insoluble fibers are the major stress-bearing components of connective tissues such as bone, teeth, cartilage, tendon, and the fibrous matrices of skin and blood vessels. A single collagen molecule consists of three polypeptide chains. Mammals

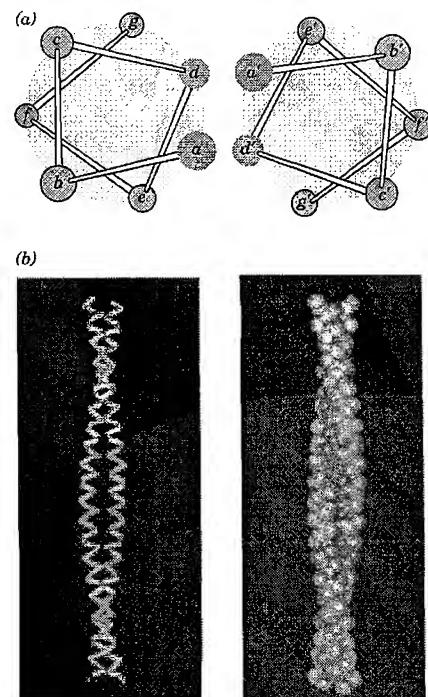
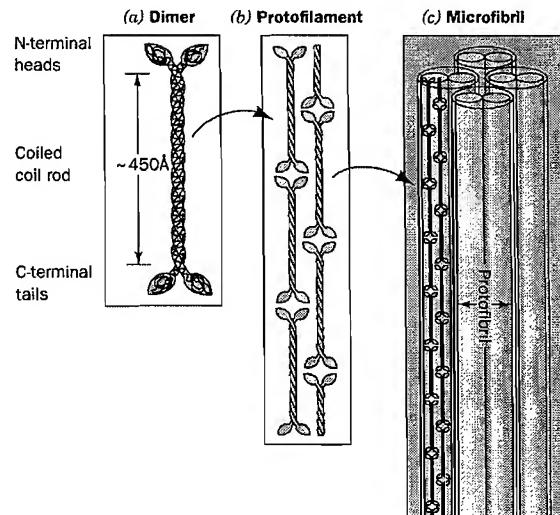


Figure 6-14 A coiled coil. (a) View down the coil axis showing the alignment of nonpolar residues along one side of each α helix. The helices have the pseudorepeating sequence $a-b-c-d-e-f-g$ in which residues a and d are predominately nonpolar. [After McLachlan, A.D. and Stewart, M., *J. Mol. Biol.* **98**, 295 (1975).] (b) Side view of the polypeptide backbones in skeletal (left) and space-filling (right) forms. Note that the side chains (red spheres in the space-filling model) contact each other. This coiled coil is from the protein tropomyosin. [Courtesy of Carolyn Cohen, Brandeis University.] See Kinemage Exercises 4-1 and 4-2.

Figure 6-15 Higher order α keratin structure. (a) Two keratin polypeptides form a dimeric coiled coil. (b) Protofilaments are formed from two staggered rows of head-to-tail associated coiled coils. (c) Protofilaments dimerize to form a protofibril, four of which form a microfibril. The structures of the latter assemblies are poorly characterized.